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1. Your reference — JMC/TY/P9048GB

2. Patent application number *(The Patent Office will fill in this part)* — 0213368.4

11 JUN 2002
127JW02 E725A03-13 D02719
P01/7700 0.00-0213368.4

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

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Patents ADP number *(if you know it)* 8321267001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — NON-WOVEN FABRIC

5. Name of your agent *(if you have one)* — DAVID KELTIE ASSOCIATES

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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2 Fleet Place
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Patents ADP number *(if you know it)* 4014502006

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
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Continuation sheets of this form	
Description	12
Claim(s)	1
Abstract	
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Priority documents	
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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature David Keith Associated Date 11 JUNE 2002

12. Name and daytime telephone number of person to contact in the United Kingdom TUBA YAMAC 020 7583 6000

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"Non-Woven Fabric"

This invention relates to non-woven fabrics, and in particular to a method of making fabrics by spraying fibres onto a support member, and to a mixture of fibres and diluent for use in the method of the invention.

Accordingly the present invention provides a method of spraying fibres, comprising the steps of preparing a composition including at least one diluent, such as a solvent, a binder and fibres; mixing the above components to provide a homogeneous suspension; and spraying the composition with a two-fluid spray gun onto a suitable support surface.

The invention also extends to a spray mixture comprising a suspension of small fibres homogeneously mixed in a suitable diluent such as acetone, together with a binder such as a polymer binder. The fibres should be of 'dispersible' dimensions and sufficiently small to flow through the nozzle of a spray gun.

Preferably the fibre length is in the range of 0.02 - 0.15 mm.

Both synthetic and natural fibres may be used. Examples of fibres which may be used include:

- Cotton fibres
- Wool fibres
- Silk fibres
- Cashmere fibres
- Linen fibres
- Seaweed cellulose fibres
- Ramie cellulose fibres
- Mink fur fibres
- Rabbit hair
- Aramid fibres
- Chitosan fibres
- Other natural fibres

- Charcoal fibres
- Carbon fibres
- Fibre optic fibres
- Glass fibres
- Metallic fibres e.g., steel, copper, silver etc..
- Ceramic fibres

For different colours of spray-on fabric, dyed fibres may be used, or small quantities of dye can be added directly to the diluent. Food dyes are particularly suitable, but any dye soluble in the diluent can be used.

Other materials that could be added to the formulation to be sprayed along with the fibres include:

- Wood (saw dust)
- Feathers
- Metallic powders e.g., steel, copper, silver etc..
- Titanium dioxide
- Nano-silica
- Micro/ nanocapsules containing :
  - Oils: e.g. citronella, eucalyptus, neem etc
  - Perfumes
  - Drugs
  - Vitamins
  - Surfactants
  - Moisturisers
  - Natural antibiotics
  - Proteins
  - Health & beauty products such as: deodorants and antiperspirants

Alternatively, these materials may be applied to the sprayed-on fabric.

The diluent may for example be a solvent such as acetone or ethyl acetate. The binder may be polymeric, polyvinyl acetate (PVA) being particularly suitable. The binder prevents the sprayed fibres from aggregating and binds the sprayed material together

once dried. If the spray-on fabric is required to adhere to a surface, an adhesive agent may also be incorporated. Adhesives used for spray contact photographic mounting are particularly suitable.

Applications

The methods and compositions of the invention may be used for a wide range of applications, some of which are listed below:

1. Spray on embroidery for clothing and furniture
2. Seamless clothing: if a pair of trousers (for example) is sprayed onto a mould and unpeeled from the mould there will be no seams in the final garment.
3. Millinery, where hats can be made by spraying fabric to a mould, this would make the production considerably cheaper
4. Joining and repairing fabrics/clothing
5. Direct spraying onto the human body e.g. tattoos, visible perfume, scratch and sniff
6. Lining for garments
7. Producing 'smart' clothing e.g. a jacket with a mobile phone incorporated to it by spraying over the 'smart' device, for example
8. Sportswear, e.g. spray on ankle, knee supports etc
9. Bandages e.g. burns bandages or fracture casts
10. Controlled release patches, such as nicotine patches, insulin patches, spray-on patch for menopause, spray-on patch for contraceptive
11. Applying a fabric feel to hard surfaces, such as plastics, wood, metal etc.
12. Laminating
13. Finishing
14. Embossing
15. Adhesives
16. Bonding or holding items against clothing or skin e.g. sensors (thermal sensors or to protect from UV light), or microchips
17. Home furniture, car interiors, planes, hospitals and military applications etc
18. Covering membrane garments and a multitude of other structures from a bra to a temporary tent for example
19. Other applications could include using the technology as an instant cleaning

product without using the process of the washing machine and as a solar power spray to charge technology in garments.

20. Spray-on fabric can be charged with a battery or from electric power to make the non woven fabric conductive for a period of time.

21. Spray-on fabric technology can be sprayed by spray-jet for industrial applications (e.g. J-cloths, shoe-shine cloths etc.) and also can be used in computerised ink-jet printers for any surfaces: fabrics, paper, hard surfaces etc

22. Can also be used for the following technologies:

- Lotions transferred to the skin to moisturise and heal etc..
- Aluminium powder
- Polymer technology
- Nano-technology
- Nano-sensors
- Nano-clay
- Particles
- Particles absorbing UV
- Bio-chips
- Anti-bacterial
- Molecular
- Nano-medicine
- Nano-composites
- Nano-bioengineering

Some embodiments and applications of the invention will now be described by way of example.

Ethyl acetate as diluent

A first formulation of the spray-on fabric designed to be easily separated from a surface onto which it is sprayed is as follows:

Diluent:	Ethyl acetate	38.5 g
Binder:	Polyvinyl acetate (PVA) (Mw 140.000)	4.0 g
Fibres:	Cellulose powder (length of fibres = 0.02 - 0.15 mm)	4.4 g
Adhesive:	Spray contact (3M photo mount 520 400ml/260g)	1 g
Other	Food dye	2 g

Firstly the ethyl acetate is poured into a glass container after which the spray contact adhesive is added. The solution is then stirred for a few minutes until the acetate is completely dissolved. Then the PVA is added and stirred for one hour until it is completely dissolved. Subsequently the food dye is added and the mixture is allowed to stir for a few minutes. Finally the Cellulose powder is added and stirred for 45 minutes to obtain a homogeneous mixture. This will give a mixture that can be applied on a surface with a two-fluid spray gun, the other fluid in this case, being air.

The assessment of a formulation's quality was made on the basis of parameters such as finish, texture and applicability.

When this formulation is sprayed on a surface it has good cohesive properties, which allows the embedding of other materials for example, feathers. After drying, this material can be readily separated from the surface to which it is sprayed, but if it is required to adhere to a surface the amount of spray contact photo-mount adhesive can be increased to about 4 g.

Acetone as diluent

An alternative formulation, for forming a fabric which is intended to be permanently adhered to a surface, is as follows:

Diluent:	Acetone	38.5 g
Binder:	Polyvinyl acetate (PVA) (Mw 140.000)	6.5 g
Fibres:	Cellulose powder (length of fibres = 0.02 - 0.15 mm)	4.9 g
Adhesive:	Epoxy resin (Epikote 1004)	0.1 g

Firstly the acetone is poured into a beaker and the Epikote epoxy resin is added and subsequently stirred for 40 minutes. When the Epikote epoxy resin is dissolved in the acetone giving a homogeneous solution, the PVA is added. This mixture is stirred for at least one hour to dissolve the PVA. Finally the cellulose powder is added and this mixture is stirred for another hour to obtain a homogeneous solution that is suitable to spray with a two-fluid spray gun.

When this formulation has dried completely it adheres well to a fabric support surface.

In reaching this composition, other compositions of the same mixture were investigated, as set out below:

An alternative composition to the above is shown below:

Diluent:	Acetone	38.5 g
Binder:	Polyvinyl acetate (PVA) (Mw 140.000)	6.5 g
Fibres:	Cellulose powder (length of fibres = 0.02 - 0.15 mm)	4.4 g
Adhesive:	Epoxy resin (Epikote 1004)	0.6 g

As with the previous composition, this formulation adhered well to a piece of denim when sprayed, forming a fabric-like covering on the denim surface.

Other formulations were prepared by mixing the components and stirring them on a magnetic stirrer for over an hour, as set out below:

Acetone (g)	**PVA Mwt (g)**	**Cellulose (g)**	**Epikote (g)**	**Comments**
38.5	6.5	4.4	0.6	Gave a nice uniform fabric like finish. Well adhered
38.5	4.0	4.4	0.6	Gave a fabric with an appearance of tissue paper Well adhered
38.5	3.0	4.4	0.6	Gave a softer more uniform, less feathery fabric Well adhered
38.5	2.0	4.4	0.6	Rather non-uniform feathery fabric formed. Well adhered
38.5	1.0	4.4	0.6	Rather similar to 2.0 g PVA
38.5	0.5	4.4	0.6	Nice uniform appearance. Rather unfabric like though. Well adhered

38.5	0.025	4.4	0.6	Nice uniform appearance. Rather unfabric like though. Well adhered
38.5	6.5	4.4	0.2	Coarse fabric appearance. Well adhered
38.5	6.5	4.4	0.1	Coarse fabric like appearance, rather fragile
38.5	6.5	4.4	0.05	Fragile, but tissue like, soft feel
38.5	6.5	4.4	0.025	Still fragile and soft, easily separated form denim
38.5	13.0	8.0	0.6	A stiff product formed, Rather hard, it breaks and cannot be separated from the denim
38.5	16	2	0.6	Similar to example above
38.5	6.5	0	0.6	Gave a smooth surface, some fabric like character, rather stretchy. Well adhered
38.5	0	4.4	0.6	Rough texture, like sandpaper, formulation tended to block nozzle, not nice
38.5	6.5	4.3	0.5	Resultant coating had the feel of stiff tissue paper, Fairly flexible- a reasonable result
38.5	6.5	4.8	0.2	Reasonably flexible material but does crack eventually. Texture is rather rugged (brush-like)
38.5	6.5	4.7	0.3	Soft like stiff chiffon. Material that hangs over the edge of the substrate is rather flexible.
38.5	6.5	4.6	0.4	Adheres strongly to the substrate. Considerably stiffer with a natural look. Reminiscent of cotton
38.5	6.5	4.5	0.5	Fragile. Adheres quite strongly to substrate and has a cobweb-like appearance
38.5	6.5	4.9	0.1	Strongly adhered to the fabric. Very homogeneous and flexible with a texture that was markedly different to the others – paper Mache

Natural latex as binder

Natural latex was considered as an alternative to PVA. The PVA was wholly or partly replaced by a natural latex, as shown below:

Acetone (g)	PVA Mwt (g)	Latex (g)	Cellulose (g)	Comment
38.5	0.0	6.5	4.4	Smooth surface no cracks very flexible, non-fabric like
38.5	4.9	6.0	4.4	More fabric like, some flexibility
38.5	2.0	4.5	4.4	Similar to plain latex, very flexible
38.5	3.0	3.5	4.4	More fabric like, some flexibility
38.5	4	2	4.4	Same as above
38.5	5	1	4.4	More fabric like but sample more brittle and fractures on bending, tending to peel off
38.5	6.5	0.0	4.4	fragile and soft, easily separated from denim

Methanol as diluent

Methanol (g)	PVA Mwt (g)	Cellulose (g)	Comment
40.0	5.0	4.0	Even film produced but surface texture not ideal
30.0	5.0	4.0	As above, texture not very good
30.0	10.0	8.0	Uneven film

Polyvinyl butyrate (PVB) as binder

Further experiments were conducted where PVA was replaced by polyvinyl butyrate (PVB).

39 g of a 5% polyvinyl butyrate (PVB) solution was mixed with Epikote (0.2g) and 4.4g of cellulose powders (length of fibres = 0.02-0.15 mm). When this was sprayed on to denim, it caused the fabric to roll up a bit. This has not been observed for other compositions. The surface was rough like sand paper.

Other materials that could be used as a binder

- Nylon-nanoclay
- Polyamide-clay

- Dendrimers
- Polyamide
- Viscose
- Silicones

Water Based systems

Two solutions of 5% polyvinyl alcohol, one 87%-89% hydrolysed in water, and the other 98%-99% hydrolysed in water, were made. To 38.5 g of both of these solutions, 0.1 g of an ABA copolymer of ethyleneoxide + propyleneoxide, Pluronic P105 and 4.4g of cellulose powders were added. These solutions tended to block the nozzle on occasions. When the nozzle remained unblocked, the sprayed solutions resulted in a smooth flexible coating. Note also that the two different samples of polyvinyl alcohol used, produced similar fabrics, and that in both cases drying in these water based systems was a bit of a problem.

Two-fluid spray gun

In the above, air was one of the fluids, with the other fluid being the suspension. However, any unreactive gas would be suitable as a propellant.

Other modes of spraying

In addition to spraying using a two-fluid spray gun, other means of spraying the suspension include:

- spray guns with a suction/pressure feed
- gravity feed spray gun
- aerosol sprays

Although any atomising spray device would work so long as the nozzle did not block.

Discussion of some of the possible applications of non-woven spray-on fabric

Textile Design Applications

Spray-on fabric can also be used to create fabric effects on other fabrics or directly onto the skin. Depending on the thickness of the applied layer, customised degrees of transparency and opacity can be obtained, and the same spray can be used for winter

or summer clothing.

Depending on the concentration of suspended particles, and in the size and design of the spray nozzle, the fabric can be diffused in various ways from thin jets to dispersed clouds of varying density.

It can also be used to simulate embroidery, to provide multiple surfaces giving 3D and embroidery-effects.

Fashion Design Applications

Spray-on fabric can be used as a substitute for hand sewing. Its flexible and innovative nature makes it a very attractive product for "haute couture", allowing the production of sophisticated instant garments and details. For example it can be used to create collars, pockets and embedding of beads, sequences or crystals, reducing drastically the production times and the costs of garments.

High Street fashions can also benefit from spray-on fabric applications. It can help bridge the gap between costly and exclusive hand-sewn couture pieces, and mass produced clothing. High Street customers will have a wider choice when buying. They might acquire a designer's item that already incorporates spray-on fabric, or buy a standard item and customise it using the spray themselves. Time consuming ornamental techniques can be revolutionised by the spraying technique. Also, clothes from different seasons can be updated easily and at a low cost, an important feature for a society that is demanding more sustainable forms of consumption.
Applications: Instant pockets, collars, sleeves, easily removable and re-locatable fastening and sealing pockets, jackets, etc, ornamental techniques (embedding, embroidery).

Manufacturing Uses

Most techniques used in clothing manufacturing can be recreated by the applications of Spray-on fabric. The development of the product takes into account the way in which garments, are constructed, with the view to quicken and simplify the manufacturing of clothes. Some of the ways in which spray-on fabric can be used to

substitute or complement current techniques are outlined below.

Design

Spray-on fabric can be used by fashion designers as a 3-D sketch tool in conjunction with traditional sketching techniques, such as hand drawing, computer graphics. It can revolutionise the making of scale models, allowing work directly on mannequins, in life-size and getting the real feel of fabric.

Pattern

The making of patterns can be speeded up by spraying the fabric directly onto a mannequin or a model, and then simply peeling it off. Using the spray for pattern making can make the need for paper patterns redundant, as the peeled off pattern functions both as a pattern and a toile.

Fitting & Correction of Patterns

During fittings, different sections of the garment can be worked on without resorting to pins and sewing. This would not only mean a speeding up of the fitting process, but it is also a much more flexible and creative way of rearranging sections and details. Using spray-on fabric for fittings gives designers a chance to introduce substantial changes to a garment, past the design stage.

Spray-on fabric also allows the amalgamation of pattern and toile into one, turning fitting and correction of patterns into a single combined task.

Construction of the Garment

The process of interlining can be improved with the application of spray-on fabric. Interlinings between the top cloth and the inside lining are used to keep the shape of the garment, but also to reinforce, layer or insulate. Any material or garment could be interlined with a felt-like spray-on fabric.

Interfacing can be simplified by the application of thicker layers of spray-on fabric to selected parts such as collars and cuffs.

Spray-on fabric can be used in several ways for binding. It can function simply as an adhesive material, holding the top cloth, padding and lining together; but also as a padding material in its own right. The spray-on fabric solution can be made water-resistant, anti-static, or flame-resistant, increasing its versatility and functionality as an interlining material.

Other possible applications include making garments with embedded electronic

devices such as telecommunication devices, body state sensors, or different kinds of transducers; making garments including heating elements, and producing fabrics which have electrically conducting or 'touch sensitive' properties.